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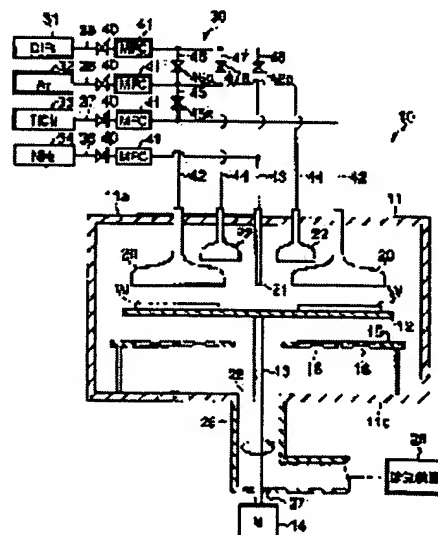
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## (54) FILM DEPOSITING APPARATUS AND FILM DEPOSITING METHOD

(57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a film depositing apparatus and a film depositing method in which an ALD method can be used with a high productivity without using any high-speed switching valve.

**SOLUTION:** The film depositing apparatus comprises a chamber 11 which houses a substrate W, a substrate support member 12 to support a plurality of substrate W in one plane in the chamber 11, a first treatment gas ejecting nozzle 20 which is provided in the chamber 11 and ejects  $\text{TiCl}_4$ , a second treatment gas ejecting nozzle 21 which ejects  $\text{NH}_3$ , a rotary mechanism 14 to rotate the substrate support member 12, and a heater 16 to heat the substrate W, and a Ti monatomic layer and a N monatomic layer are alternately formed on the substrate W while rotating the substrate support member 12 to revolve the substrate W.



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**CLAIMS**


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[Claim(s)]

[Claim 1] The chamber which holds a substrate, and the substrate supporter material which supports superficially two or more substrates within said chamber, The 1st raw gas discharge part which is prepared in said chamber and carries out the regurgitation of the 1st raw gas, The 2nd raw gas discharge part which is prepared in a different location from the 1st raw gas discharge part in said chamber, and carries out the regurgitation of the 2nd raw gas, Providing the rolling mechanism which rotates said substrate supporter material, and a heating means to heat said substrate, rotating said substrate supporter material, and making a substrate revolve around the sun Membrane formation equipment characterized by forming the monoatomic layer by the 1st raw gas, and the monoatomic layer by the 2nd raw gas by turns on a substrate.

[Claim 2] Membrane formation equipment according to claim 1 characterized by arranging two or more preparations and these by turns in the shape of a periphery in said 1st raw gas discharge part and said 2nd raw gas discharge part.

[Claim 3] Membrane formation equipment according to claim 2 characterized by having the purge gas discharge part which carries out the regurgitation of the purge gas between said 1st raw gas discharge part and said 2nd raw gas discharge part.

[Claim 4] Said rolling mechanism is membrane formation equipment given in any 1 term of claim 1 to claim 3 characterized by rotating said substrate supporter material so that the substrate supported by said substrate supporter material may pass directly under said 1st raw gas discharge part and the 2nd raw gas discharge part.

[Claim 5] Membrane formation equipment given in any 1 term of claim 1 to claim 4 characterized by having further the substrate rolling mechanism which makes said substrate rotate.

[Claim 6] Said heating means is membrane formation equipment given in any 1 term of claim 1 to claim 5 characterized by heating a substrate from the lower part of said substrate supporter material.

[Claim 7] Said heating means is membrane formation equipment given in any 1 term of claim 1 to claim 6 characterized by heating a substrate from the upper part of the substrate supported by said substrate supporter material.

[Claim 8] For said 2nd raw gas, said 1st raw gas is membrane formation equipment given in any 1 term of claim 1 to claim 7 characterized by including N or O including any one sort in aluminum, Zr, Ti, Ta, Si, W, and Ru.

[Claim 9] Membrane formation equipment given in any 1 term of claim 1 to claim 7 characterized by forming one of aluminum 2O<sub>3</sub>, ZrO<sub>2</sub>, TiN, TaN, SiO<sub>2</sub> and SiN, SiON, SiOF, and any WN, WSi, and RuO<sub>2</sub> sorts.

[Claim 10] So that the plurality of the process which divides the inside of a chamber into two or more space with the air curtain of the gas stream breathed out in the chamber, and the raw gas ambient atmosphere which comes to introduce predetermined raw gas into each of said space may be passed The membrane formation approach characterized by providing the process to which a substrate is repeated and moved, and the process which form a monoatomic layer continuously, make it deposit, and this is made to react thermally, and forms the film of a compound on said substrate by this.

[Claim 11] Said raw gas is the membrane formation approach according to claim 10 characterized by having the 1st raw gas which contains any one sort of elements among aluminum, Zr, Ti, Ta, Si, W, and Ru, and the 2nd raw gas containing N or O.

[Claim 12] The membrane formation approach characterized by breathing out the 1st raw gas and 2nd raw gas, respectively from the 1st raw gas discharge part established in a mutually different location in a chamber, and the 2nd raw gas discharge part, and forming the monoatomic layer by the 1st raw gas, and the monoatomic layer by the 2nd raw gas by turns on a substrate, arranging two or more substrates within a chamber superficially, and

making a substrate revolve around the sun.

[Claim 13] The membrane formation approach according to claim 12 characterized by making a substrate rotate furthermore.

[Claim 14] The membrane formation approach according to claim 12 or 13 characterized by for the 1st and 2nd raw gas doubling the degree of \*\*\*\*\*, and making a substrate revolve around the sun.

[Claim 15] For said 2nd raw gas, said 1st raw gas is the membrane formation approach given in any 1 term of claim 12 to claim 14 characterized by including N or O including any one sort in aluminum, Zr, Ti, Ta, Si, W, and Ru.

[Claim 16] The membrane formation approach given in any 1 term of claim 10 to claim 15 characterized by forming one of aluminum  $2O_3$ ,  $ZrO_2$ ,  $TiN$ ,  $TaN$ ,  $SiO_2$  and  $SiN$ ,  $SiON$ ,  $SiOF$ , and any  $WN$ ,  $WSi$ , and  $RuO_2$  sorts.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention -- the TiN film etc. -- ALD (Atomic Layer Deposition) -- it is related with the membrane formation equipment and the membrane formation approach of forming membranes using law.

[0002]

[Description of the Prior Art] In a semi-conductor production process, in order to embed the hole during wiring formed in the semi-conductor wafer (it is only hereafter described as a wafer) which is a processed object, as a barrier layer, metallic compounds, such as WSi (tungsten silicide), TiN (titanium nitride), and TiSi (titanium silicide), are made to deposit, and the thin film is formed.

[0003] Although these metallic-compounds thin film was conventionally formed using physical vacuum evaporation (PVD), it is difficult to require especially detailed-izing and high integration of a device like recently, and for the design rule to be severe and to acquire property sufficient in PVD with bad embedding nature especially. Then, forming the TiN film by the chemical vacuum evaporation (CVD) which can expect to form the better film is performed.

[0004] The adhesion of membraneous quality, step coverage, and the film has stopped however, necessarily being able to say that it is enough also by CVD. Moreover, the thickness control at the time of forming a super-thin film 10nm or less is very difficult.

[0005] It considers as the technique which, on the other hand, forms the metallic-compounds thin film of good membraneous quality with adhesion and sufficient step coverage, and the ALD method attracts attention recently (JP,55-130896,A etc.). Therefore, it is possible to use the ALD method also in deposition of the above-mentioned metallic compounds. In case the TiN film is formed, arrange one wafer in a chamber, supply  $\text{TiCl}_4$  gas in a chamber first, make the monoatomic layer of Ti adsorb, subsequently supply  $\text{NH}_3$  gas, the monoatomic layer of N is made to deposit on it, and these are made to specifically react. The TiN film of predetermined thickness is obtained by repeating this actuation the number of predetermined times.

[0006]

[Problem(s) to be Solved by the Invention] However, although the gas to supply must be changed at high speed, therefore a high-speed switching valve is used in case a metallic-compounds thin film is formed using the ALD method, such a high-speed switching valve has the trouble that a life is short. Moreover, since it is necessary to supply purge gas and to purge front gas while supplying the gas of another side, after supplying one gas in case the laminating of the monoatomic layer is carried out in this way, membrane formation takes time amount and the trouble of being bad also has productivity.

[0007] This invention is made in view of this situation, and without using a high-speed switching valve, it is high productivity and aims at offering the membrane formation equipment and the membrane formation approach of using the ALD method.

[0008]

[Means for Solving the Problem] The chamber in which this invention holds a substrate in order to solve the above-mentioned technical problem, The substrate supporter material which supports superficially two or more substrates within said chamber, The 1st raw gas discharge part which is prepared in said chamber and carries out the regurgitation of the 1st raw gas, The 2nd raw gas discharge part which is prepared in a different location from the 1st raw gas discharge part in said chamber, and carries out the regurgitation of the 2nd raw gas, Providing the rolling mechanism which rotates said substrate supporter material, and a heating means to heat said substrate, rotating said substrate supporter material, and making a substrate revolve around the sun The

membrane formation equipment characterized by forming the monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas by turns on a substrate is offered.

[0009] Moreover, this invention so that the plurality of the process which divides the inside of a chamber into two or more space with the air curtain of the gas stream breathed out in the chamber, and the raw gas ambient atmosphere which comes to introduce predetermined raw gas into each of said space may be passed. The membrane formation approach characterized by providing the process to which a substrate is repeated and moved, and the process which form a monoatomic layer continuously, make it deposit, and this is made to react thermally, and forms the film of a compound on said substrate by this is offered.

[0010] Furthermore, this invention arranging two or more substrates within a chamber superficially, and making a substrate revolve around the sun. The 1st raw gas and 2nd raw gas are breathed out, respectively from the 1st raw gas discharge part established in a mutually different location in a chamber, and the 2nd raw gas discharge part. The membrane formation approach characterized by forming the monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas by turns on a substrate is offered.

[0011] In forming membranes using the ALD method according to this invention, the 1st raw gas and 2nd raw gas, respectively from the 2nd raw gas discharge part which carries out the regurgitation of the 1st raw gas discharge part and 2nd raw gas which were formed in a mutually different location. Discharge, Without using a high-speed switching valve, since substrate supporter material is rotated and a substrate is made to revolve around the sun, the 1st raw gas and 2nd raw gas can be supplied by turns on a substrate, and the monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas can be formed by turns. Moreover, since it processes where two or more substrates are supported to substrate supporter material, membrane formation processing of the substrate of two or more sheet number can be performed at once, and productivity can be raised.

[0012] In said membrane formation equipment, it is desirable that two or more preparations and these are arranged by turns in the shape of a periphery in said 1st raw gas discharge part and said 2nd raw gas discharge part. Thereby, membranes can be formed by being more efficient.

[0013] It is desirable to have the purge gas discharge part which carries out the regurgitation of the purge gas between said 1st raw gas discharge part and said 2nd raw gas discharge part. Thereby, the separability of the 1st raw gas and the 2nd raw gas can be raised.

[0014] As for said rolling mechanism, it is desirable to rotate said substrate supporter material so that the substrate supported by said substrate supporter material may pass directly under said 1st raw gas discharge part and the 2nd raw gas discharge part. Thereby, a monoatomic layer can be certainly formed on a substrate.

[0015] It is desirable to have further the substrate rolling mechanism which makes said substrate rotate. Thus, by making a substrate rotate, the homogeneity of membrane formation can be raised more.

[0016] You may make it said heating means heat a substrate from the lower part of said substrate supporter material, and may make it heat a substrate from the upper part of the substrate supported by said substrate supporter material.

[0017] In said membrane formation approach, it is desirable to make a substrate rotate further. Moreover, it is desirable for the 1st and 2nd raw gas to double the degree of \*\*\*\*\*, and to make a substrate revolve around the sun.

[0018] The thing containing any one sort in aluminum, Zr, Ti, Ta, Si, W, and Ru can be used for said 1st raw gas, and said 2nd raw gas can use the thing containing N or O.

[0019] Said membrane formation equipment and said membrane formation approach are applicable to any one sort of membrane formation aluminum 2O<sub>3</sub>, ZrO<sub>2</sub>, TiN, TaN, SiO<sub>2</sub> and SiN, SiON, SiOF, and among WN, WSi, and RuO<sub>2</sub>.

[0020]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to an accompanying drawing. The sectional view and drawing 2 which show the membrane formation equipment which drawing 1 requires for 1 operation gestalt of this invention are the top view of the interior. Here, the case where the TiN film is formed with the CVD membrane formation equipment using the ALD method is explained.

[0021] This CVD membrane formation equipment 10 has the approximately cylindrical chamber 11 constituted possible [ vacuum suction ], and the wafer W which is a processed object is formed in the wafer supporter material 12 in which four-sheet support is horizontally possible in it. The wafer supporter material 12 has four

wafers supporter 12a, as shown in drawing 2, and Wafer W is supported by these. Moreover, the revolving shaft 13 prolonged caudad is formed in the core of the wafer supporter material 12, and this revolving shaft 13 is attached in the shaft of a motor 14. And the wafer supporter material 12 rotates along the direction of an arrow head of drawing 2 by rotating this motor 14 through a revolving shaft 13. Therefore, the wafer W supported by wafer supporter 12a revolves the surroundings of a revolving shaft 13 around the sun by rotation of the wafer supporter material 12.

[0022] Under the wafer supporter material 12, the heater supporter material 15 is formed and the heater 16 of the shape of a circular ring of the inside and two outsides is supported by this heater supporter material 15 along with the migration locus of Wafer W.

[0023] The 1st raw gas regurgitation nozzle (1st raw gas discharge part) 20 and the 2nd raw gas regurgitation nozzle (2nd raw gas discharge part) 21 are formed in ceiling wall 11a of a chamber 11 in the condition of having made the gas deliveries 20a and 20b countering the top face of the wafer supporter material 12. The raw gas regurgitation nozzle 20 of these 1st and every 2nd two raw gas regurgitation nozzle 21 are formed as shown in drawing 2, and these are arranged in the shape of a periphery along with the migration locus of Wafer W by turns. Moreover, the adjoining 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21 are arranged at the include angle of 90 degrees centering on the revolving shaft 13. Moreover, it is prepared in ceiling wall 11a of a chamber 11 so that it may be located between the 1st raw gas regurgitation nozzle 20 which four purge gas regurgitation nozzles (purge gas discharge part) 22 adjoin, and the 2nd raw gas regurgitation nozzle 21.

[0024] Drawing 3 (a) is the sectional view of the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21. As shown in drawing 3 (a), the 1st and 2nd raw gas regurgitation nozzles 20 and 21 have many gas deliveries 20a and 21a, respectively, and they are constituted so that the regurgitation of the raw gas may be carried out to the shape of a shower into a chamber 11 from the deliveries 20a and 21a of these large number. Moreover, drawing 3 (b) is the sectional view of the purge gas regurgitation nozzle 22. As shown in drawing 3 (b), the purge gas regurgitation nozzle 22 While having skirt-board section 22b in which delivery 22a of a large number prepared in the interior and delivery 22a of these large number were prepared caudad and carrying out the regurgitation of the raw gas to the shape of a shower into a chamber 11 from delivery 20a It has prevented that the flow of the purge gas breathed out by skirt-board section 22b in the shape of a shower is spread, and it is constituted so that the downflow of purge gas may make an air curtain by this.

[0025] Moreover, gas delivery 22a of the purge gas regurgitation nozzle 22 is prepared more nearly up than the gas deliveries 20a and 21a of the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21, and, thereby, is disengageable with the air curtain of purge gas about the 1st raw gas ambient atmosphere and the 2nd raw gas ambient atmosphere. Predetermined gas is supplied from these nozzles 20, 21, and 22 by the gas supply device 30 mentioned later.

[0026] The gas supply device 30 has ClF<sub>3</sub> source of supply 31 which supplies ClF<sub>3</sub> which is cleaning gas, the Ar source of supply 32 which supplies Ar, TiCl<sub>4</sub> source of supply 33 which supplies TiCl<sub>4</sub>, and NH<sub>3</sub> source of supply 34 which supplies NH<sub>3</sub>. and -- ClF<sub>3</sub> source of supply 31 -- ClF<sub>3</sub> gas line 35 -- TiCl<sub>4</sub> gas line 37 is connected to TiCl<sub>4</sub> source of supply 33, and NH<sub>3</sub> gas line 38 is connected to NH<sub>3</sub> source of supply 34 for the Ar gas line 36 at the Ar source of supply 32, respectively. And the bulb 40 and the massflow controller 41 are formed in each Rhine.

[0027] TiCl<sub>4</sub> gas line 37 prolonged from TiCl<sub>4</sub> source of supply 33 is connected to the gas piping 42 prolonged from the 1st raw gas regurgitation nozzle 20. Moreover, the piping 45 prolonged from the Ar gas line 36 is connected to TiCl<sub>4</sub> gas line 37, and TiCl<sub>4</sub> gas by which the carrier was carried out to Ar gas is breathed out from the 1st raw gas regurgitation nozzle 20 through piping 42. Moreover, NH<sub>3</sub> gas line 38 prolonged from NH<sub>3</sub> source of supply 34 is connected to the gas piping 43 prolonged from the 2nd raw gas regurgitation nozzle 21, and NH<sub>3</sub> gas is breathed out from the 2nd raw gas regurgitation nozzle 21 through NH<sub>3</sub> gas line 38 and gas piping 43. Furthermore, the Ar gas line 36 prolonged from the Ar source of supply 32 is connected to the piping 44 prolonged from the purge gas regurgitation nozzle 22, and Ar gas is breathed out from the purge gas regurgitation nozzle 22 through the Ar gas line 36 and piping 44. Piping 46, 47, and 48 is connected to ClF<sub>3</sub> gas line 35 prolonged from ClF<sub>3</sub> source of supply 31 further again, and the regurgitation [ ClF<sub>3</sub> gas which is cleaning gas through these piping 46, 47, and 48 to the piping 42, 43, and 44 from the 1st raw gas regurgitation nozzle 20, the 2nd raw gas regurgitation nozzle 21, and the purge gas regurgitation nozzle 22 ] is possible. In addition, Bulbs 45a, 46a, 47a, and 48a are formed in piping 45, 46, 47, and 48, respectively.

[0028] The exhaust port 25 is established in that center section at bottom wall 11b of a chamber 11, and the exhaust pipe 26 is connected to this exhaust port 25. The exhauster 28 is connected to this exhaust pipe 26, and the inside of a chamber 11 can be decompressed to a predetermined degree of vacuum by operating an exhauster 28.

[0029] In addition, an exhaust pipe 26 is prolonged in a perpendicular direction lower part from an exhaust port 25, is the middle and is crooked horizontally, said revolving shaft 13 passed along the inside of the vertical section of an exhaust pipe 26, the tube wall of the horizontal level of an exhaust pipe 26 was penetrated, it has extended below, and the fluid seal 27 is formed between the tube wall and revolving shaft 13.

[0030] Thus, in the constituted CVD membrane formation equipment, first, the semi-conductor wafer W is inserted in in a chamber 11, and Wafer W is laid in wafer supporter 12a of the wafer supporter material 12. Subsequently, the wafer supporter material 12 is rotated heating Wafer W from a heater 16, the inside of a chamber 11 is exhausted with an exhauster 28, and the inside of a chamber 11 is made into a predetermined vacua. Then, Ar gas as purge gas is made to breathe out the 2nd raw gas regurgitation nozzle 21 to NH<sub>3</sub> gas for TiCl<sub>4</sub> gas which carried out the carrier to Ar from the 1st raw gas regurgitation nozzle 20 from the purge gas regurgitation nozzle 22, respectively.

[0031] About two sheets by which TiCl<sub>4</sub> gas breathed out from the 1st raw gas regurgitation nozzle 20 is supplied to the beginning among the wafers W of wafer supporter 12a of the wafer supporter material 12 After the monoatomic layer of Ti adsorbs by TiCl<sub>4</sub> supplied gas, by rotation of the wafer supporter material 12 The air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22 is passed, the monoatomic layer of N accumulates on the monoatomic layer of Ti by NH<sub>3</sub> gas breathed out from the 2nd raw gas regurgitation nozzle 21, these react, and TiN is formed. Furthermore, after passing the air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22, the monoatomic layer of Ti and the monoatomic layer of N are supplied similarly, this is repeated the number of predetermined times, and the TiN film of predetermined thickness is formed. moreover, about other two sheets to which NH<sub>3</sub> gas first breathed out from the 2nd raw gas regurgitation nozzle 21 is supplied After the monoatomic layer of N adsorbs by NH<sub>3</sub> supplied gas, by rotation of the wafer supporter material 12 The air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22 is passed, the monoatomic layer of Ti accumulates on the monoatomic layer of N by TiCl<sub>4</sub> gas breathed out from the 1st raw gas regurgitation nozzle 20, these react, and TiN is formed. Furthermore, after passing the air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22, the monoatomic layer of N and the monoatomic layer of Ti are supplied similarly, this is repeated the number of predetermined times, and the TiN film of predetermined thickness is formed. In this case, the rotational speed of the wafer supporter material 12 is determined according to the rate of adsorption of TiCl<sub>4</sub> gas which is raw gas, and NH<sub>3</sub> gas.

[0032] Moreover, further, a quantity of gas flow is set up so that the configuration of the 1st raw gas regurgitation nozzle 20 which can be set in this case, and the 2nd raw gas regurgitation nozzle 21 and spacing with Wafer W, and flow by which a monoatomic layer sticks to Wafer W equally can be formed. Moreover, further, a quantity of gas flow is set up so that spacing of the purge gas regurgitation nozzle 22 and Wafer W and the flow as which purge gas functions considering a TiCl<sub>4</sub> gas ambient atmosphere and NH<sub>3</sub> gas ambient atmosphere as an air curtain disengageable enough can be formed. Moreover, the heating temperature of a heater 16 is set as the proper temperature suitable for the reaction of Ti and N. Hereafter, these set points are described concretely.

[0033] The 1st raw gas regurgitation nozzle 20 which has the structure shown in drawing 3 (a), and the 2nd raw gas regurgitation nozzle 21 can be arranged so that the distance h<sub>1</sub> between Deliveries 20a and 21a and the wafer W front face held at the substrate supporter material 12 located caudad may be set to 0.1-10mm. Moreover, the purge gas regurgitation nozzle 22 which has the structure shown in drawing 3 (b) can be arranged so that the distance h<sub>2</sub> between delivery 22a and the wafer W front face held at the substrate supporter material 12 located caudad may be set to 0.1-50mm, and it can be arranged so that the distance h<sub>3</sub> between the lower limit and substrate supporter material 12 top faces may be set to 1.1-50mm. Preferably, h<sub>1</sub> arranges nozzles 20, 21, and 22 so that 0.1-5mm and h<sub>2</sub> may be set to 0.2-10mm and h<sub>3</sub> may be set to 1.2-11mm.

[0034] Moreover, each quantity of gas flow at the time of TiN membrane formation, chamber internal pressure, and heating temperature can be set up as follows.

TiCl<sub>4</sub> quantity of gas flow: It is 5 - 20sccm (0.005 - 0.02 L/min) preferably one to 50 sccm (0.001 - 0.05 L/min).

Ar gas (carrier gas) flow rate: -- NH<sub>3</sub> quantity-of-gas-flow:50 which does not need to use carrier gas when 10 -



100sccm (0.01 - 0.1 L/min) and  $\text{TiCl}_4$  gas are low flow rates - 1000sccm (0.05 - 1 L/min) -- desirable -- 50 - 500sccm (0.05 - 0.5 L/min)

Purge-gas flow rate: 100 - 1000sccm (0.1 - 1 L/min)

chamber internal pressure: -- 100mTorr - 5Torr (13.3Pa - 665Pa) -- desirable -- 100mTorr(s) - 1Torr (13.3Pa - 133Pa)

Heating temperature: It is 400-600 degrees C [0035] preferably 300-700 degrees C. Supplying  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas, respectively from the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21 which have been arranged by turns as mentioned above Without using a high-speed switching valve, since the wafer supporter material 12 is rotated and  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas are supplied to Wafer W by turns, the monoatomic layer of Ti and the monoatomic layer of N can be formed by turns by the ALD method, and the desired TiN film can be formed. Moreover, since two or more wafers W are laid in the wafer supporter material 12 in this way and membrane formation processing of two or more sheets is performed by one processing, productivity is high. Moreover, since the raw gas of the part which formation of the monoatomic layer of Wafer W ended by being able to prevent that  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas are mixed by breathing out Ar gas as purge gas from the purge gas regurgitation nozzle 22, and forming an air curtain as much as possible, and carrying out the regurgitation of the Ar gas which is purge gas can be removed promptly and an excessive reaction can be prevented, the better film can be formed.

[0036] When it carries out by having repeated formation of such TiN film and membrane formation processing of the wafer W of predetermined number of sheets is completed, nozzles 20, 21, and 22 to  $\text{ClF}_3$  gas is made to breathe out through a gas line 35, piping 46, 47, and 48, and piping 42, 43, and 44 from  $\text{ClF}_3$  source 31, and the inside of a chamber 11 is cleaned.

[0037] The  $\text{ClF}_3$  quantity of gas flow at the time of this cleaning, chamber internal pressure, and cleaning temperature can be set up as shown below.

$\text{ClF}_3$  quantity of gas flow: It is 200 - 300sccm (0.2 - 0.3 L/min) preferably 100 to 500 sccm (0.1 - 0.5 L/min).

Chamber internal pressure: It is 1 - 5Torr (133-665Pa) preferably one to 10 Torr (133-1330Pa).

Cleaning temperature: It is 200-300 degrees C [0038] preferably 200-500 degrees C. Next, the CVD membrane formation equipment concerning other operation gestalten is explained. Drawing 4 is the sectional view showing partially the CVD membrane formation equipment concerning other operation gestalten. Here, it has the composition of using wafer supporter material 12' instead of the wafer supporter material 12, and making Wafer W rotating. That is, four wafer tables (two are illustrated in drawing 4 ) 52 are formed pivotable on the base member 51, and wafer supporter material 12' makes the wafer W on the wafer table 52 rotate by rotating these wafers table 52 by the motor 53. Thereby,  $\text{TiCl}_4$  gas as raw gas and  $\text{NH}_3$  gas can be further supplied to homogeneity at Wafer W, and a more uniform monoatomic layer can be formed. In this case, if a heater 16 is under wafer supporter material like drawing 1 , since heating effectiveness will worsen, it is desirable to prepare heater 16' above Wafer W like drawing 4 . 15' is heater supporter material which supports heater 16'. Thus, when a heater is formed, it is desirable to prepare the hole of a large number in which gas passage is possible in heater 16' and heater supporter material 15' so that raw gas may be supplied effective in Wafer W.

[0039] Furthermore, he is trying to supply  $\text{TiCl}_4$  gas as raw gas, and  $\text{NH}_3$  gas from the shower head 60 and the shower head 61 with the operation gestalt of drawing 5 , respectively. Much gas discharge opening 60b is formed in the inferior surface of tongue of body 60a of the hollow which makes the shape of a disk, and the shower head 60 carries out the regurgitation of the gas to homogeneity from this gas discharge opening 60b, as shown in drawing 6 . The shower head 61 is constituted similarly. Thus,  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas can be supplied to Wafer W also by using the shower head instead of a nozzle at homogeneity.

[0040] With the operation gestalt of drawing 7 , the exhaust port 70 is established directly under the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21 further again (only the exhaust port corresponding to the 1st raw gas regurgitation nozzle 20 is illustrated). By doing in this way,  $\text{TiCl}_4$  unnecessary gas and  $\text{NH}_3$  gas can be promptly discharged through the exhaust pipe 71 connected to the exhaust port 70.

[0041] In addition, this invention is variously deformable, without being limited to the gestalt of the above-mentioned implementation. For example, although the above-mentioned operation gestalt showed the example which forms the TiN film, aluminum  $2\text{O}_3$ ,  $\text{ZrO}_2$ , TaN,  $\text{SiO}_2$  and SiN, SiON, WN and WSi,  $\text{RuO}_2$  grade, and other metallic compounds can be formed similarly. Moreover, with the above-mentioned operation gestalt, although  $\text{NH}_3$  gas was used as the 2nd raw gas, using  $\text{TiCl}_4$  as the 1st raw gas, the 1st raw gas and 2nd raw gas can use the proper gas according to the metallic-compounds film which forms membranes. in such a case, as the

1st raw gas which can be set Besides  $\text{TiCl}_4$ ,  $\text{TaBr}_5$ ,  $\text{Ta}(\text{OC}_2\text{H}_5)_5$ ,  $\text{SiCl}_4$ ,  $\text{SiH}_4$ ,  $\text{Si}_2\text{H}_6$ ,  $\text{SiH}_2\text{Cl}_2$ , aluminum of WF6 grade, The thing containing one sort in Zr, Ti, Ta, Si, W, and Ru can be mentioned, and the thing containing N or O of  $\text{NH}_3$  ( $\text{N}_2$ ),  $\text{O}_2$ ,  $\text{O}_3$ ,  $\text{NO}$ ,  $\text{N}_2\text{O}$ ,  $\text{N}_2\text{O}_3$ , and  $\text{N}_2\text{O}_5$  grade other than  $\text{NH}_3$  can be mentioned as the 2nd raw gas.

[0042] Moreover, although it prepared in the example of drawing 1 and the location of a heater was prepared above the wafer in the example of drawing 4 under the wafer, you may prepare in both these, and as long as it can heat to homogeneity, you may prepare in other locations. Furthermore, although Ar gas was used as purge gas, you may be other gas, such as  $\text{N}_2$  gas. Moreover, if two raw gas can be intercepted effectively, it is not necessary to use purge gas. You may be the substrate which may be not only a semi-conductor wafer but other things as a substrate to be used, and formed other layers on the front face further again.

[0043]

[Effect of the Invention] In performing membrane formation using the ALD method according to this invention, as explained above Since discharge and substrate supporter material are rotated for the 1st raw gas and 2nd raw gas, respectively from the 2nd raw gas discharge part which carries out the regurgitation of the 1st raw gas discharge part and 2nd raw gas which were formed in a mutually different location and a substrate is made to revolve around the sun The monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas can be formed by turns, without using a high-speed switching valve. Moreover, since it processes where two or more substrates are supported to substrate supporter material, membrane formation processing of the substrate of two or more sheet number can be performed at once, and productivity can be raised.

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[Translation done.]

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**TECHNICAL FIELD**

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[Field of the Invention] this invention -- the TiN film etc. -- ALD (Atomic Layer Deposition) -- it is related with the membrane formation equipment and the membrane formation approach of forming membranes using law.

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PRIOR ART

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[Description of the Prior Art] In a semi-conductor production process, in order to embed the hole during wiring formed in the semi-conductor wafer (it is only hereafter described as a wafer) which is a processed object, as a barrier layer, metallic compounds, such as WSi (tungsten silicide), TiN (titanium nitride), and TiSi (titanium silicide), are made to deposit, and the thin film is formed.

[0003] Although these metallic-compounds thin film was conventionally formed using physical vacuum evaporation (PVD), it is difficult to require especially detailed-izing and high integration of a device like recently, and for the design rule to be severe and to acquire property sufficient in PVD with bad embedding nature especially. Then, forming the TiN film by the chemical vacuum evaporation (CVD) which can expect to form the better film is performed.

[0004] The adhesion of membraneous quality, step coverage, and the film has stopped however, necessarily being able to say that it is enough also by CVD. Moreover, the thickness control at the time of forming a super-thin film 10nm or less is very difficult.

[0005] It considers as the technique which, on the other hand, forms the metallic-compounds thin film of good membraneous quality with adhesion and sufficient step coverage, and the ALD method attracts attention recently (JP,55-130896,A etc.). Therefore, it is possible to use the ALD method also in deposition of the above-mentioned metallic compounds. In case the TiN film is formed, arrange one wafer in a chamber, supply  $\text{TiCl}_4$  gas in a chamber first, make the monoatomic layer of Ti adsorb, subsequently supply  $\text{NH}_3$  gas, the monoatomic layer of N is made to deposit on it, and these are made to specifically react. The TiN film of predetermined thickness is obtained by repeating this actuation the number of predetermined times.

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**EFFECT OF THE INVENTION**

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[Effect of the Invention] In performing membrane formation using the ALD method, discharge and substrate supporter material are rotated for the 1st raw gas and 2nd raw gas, respectively from the 2nd raw gas discharge part which carries out the regurgitation of the 1st raw gas discharge part and 2nd raw gas which were formed in a mutually different location, and a substrate is made to revolve around the sun in this invention, as explained above. Therefore, the monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas can be formed by turns, without using a high-speed switching valve. Moreover, since it processes where two or more substrates are supported to substrate supporter material, membrane formation processing of the substrate of two or more sheet number can be performed at once, and productivity can be raised.

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TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] However, although the gas to supply must be changed at high speed, therefore a high-speed switching valve is used in case a metallic-compounds thin film is formed using the ALD method, such a high-speed switching valve has the trouble that a life is short. Moreover, since it is necessary to supply purge gas and to purge front gas while supplying the gas of another side, after supplying one gas in case the laminating of the monoatomic layer is carried out in this way, membrane formation takes time amount and the trouble of being bad also has productivity.

[0007] This invention is made in view of this situation, and without using a high-speed switching valve, it is high productivity and aims at offering the membrane formation equipment and the membrane formation approach of using the ALD method.

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[Translation done.]

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MEANS

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[Means for Solving the Problem] The chamber in which this invention holds a substrate in order to solve the above-mentioned technical problem, The substrate supporter material which supports superficially two or more substrates within said chamber, The 1st raw gas discharge part which is prepared in said chamber and carries out the regurgitation of the 1st raw gas, The 2nd raw gas discharge part which is prepared in a different location from the 1st raw gas discharge part in said chamber, and carries out the regurgitation of the 2nd raw gas, Providing the rolling mechanism which rotates said substrate supporter material, and a heating means to heat said substrate, rotating said substrate supporter material, and making a substrate revolve around the sun The membrane formation equipment characterized by forming the monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas by turns on a substrate is offered.

[0009] Moreover, this invention so that the plurality of the process which divides the inside of a chamber into two or more space with the air curtain of the gas stream breathed out in the chamber, and the raw gas ambient atmosphere which comes to introduce predetermined raw gas into each of said space may be passed The membrane formation approach characterized by providing the process to which a substrate is repeated and moved, and the process which form a monoatomic layer continuously, make it deposit, and this is made to react thermally, and forms the film of a compound on said substrate by this is offered.

[0010] Furthermore, this invention arranging two or more substrates within a chamber superficially, and making a substrate revolve around the sun The 1st raw gas and 2nd raw gas are breathed out, respectively from the 1st raw gas discharge part established in a mutually different location in a chamber, and the 2nd raw gas discharge part. The membrane formation approach characterized by forming the monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas by turns on a substrate is offered.

[0011] In forming membranes using the ALD method according to this invention, the 1st raw gas and 2nd raw gas, respectively from the 2nd raw gas discharge part which carries out the regurgitation of the 1st raw gas discharge part and 2nd raw gas which were formed in a mutually different location Discharge, Without using a high-speed switching valve, since substrate supporter material is rotated and a substrate is made to revolve around the sun, the 1st raw gas and 2nd raw gas can be supplied by turns on a substrate, and the monoatomic layer by the 1st raw gas and the monoatomic layer by the 2nd raw gas can be formed by turns. Moreover, since it processes where two or more substrates are supported to substrate supporter material, membrane formation processing of the substrate of two or more sheet number can be performed at once, and productivity can be raised.

[0012] In said membrane formation equipment, it is desirable that two or more preparations and these are arranged by turns in the shape of a periphery in said 1st raw gas discharge part and said 2nd raw gas discharge part. Thereby, membranes can be formed by being more efficient.

[0013] It is desirable to have the purge gas discharge part which carries out the regurgitation of the purge gas between said 1st raw gas discharge part and said 2nd raw gas discharge part. Thereby, the separability of the 1st raw gas and the 2nd raw gas can be raised.

[0014] As for said rolling mechanism, it is desirable to rotate said substrate supporter material so that the substrate supported by said substrate supporter material may pass directly under said 1st raw gas discharge part and the 2nd raw gas discharge part. Thereby, a monoatomic layer can be certainly formed on a substrate.

[0015] It is desirable to have further the substrate rolling mechanism which makes said substrate rotate. Thus, by making a substrate rotate, the homogeneity of membrane formation can be raised more.

[0016] You may make it said heating means heat a substrate from the lower part of said substrate supporter material, and may make it heat a substrate from the upper part of the substrate supported by said substrate

supporter material.

[0017] In said membrane formation approach, it is desirable to make a substrate rotate further. Moreover, it is desirable for the 1st and 2nd raw gas to double the degree of \*\*\*\*\*, and to make a substrate revolve around the sun.

[0018] The thing containing any one sort in aluminum, Zr, Ti, Ta, Si, W, and Ru can be used for said 1st raw gas, and said 2nd raw gas can use the thing containing N or O.

[0019] Said membrane formation equipment and said membrane formation approach are applicable to any one sort of membrane formation aluminum  $2O_3$ ,  $ZrO_2$ , TiN, TaN,  $SiO_2$  and SiN, SiON, SiOF, and among WN, WSi, and  $RuO_2$ .

[0020]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to an accompanying drawing. The sectional view and drawing 2 which show the membrane formation equipment which drawing 1 requires for 1 operation gestalt of this invention are the top view of the interior. Here, the case where the TiN film is formed with the CVD membrane formation equipment using the ALD method is explained.

[0021] This CVD membrane formation equipment 10 has the approximately cylindrical chamber 11 constituted possible [ vacuum suction ], and the wafer W which is a processed object is formed in the wafer supporter material 12 in which four-sheet support is horizontally possible in it. The wafer supporter material 12 has four wafers supporter 12a, as shown in drawing 2, and Wafer W is supported by these. Moreover, the revolving shaft 13 prolonged caudad is formed in the core of the wafer supporter material 12, and this revolving shaft 13 is attached in the shaft of a motor 14. And the wafer supporter material 12 rotates along the direction of an arrow head of drawing 2 by rotating this motor 14 through a revolving shaft 13. Therefore, the wafer W supported by wafer supporter 12a revolves the surroundings of a revolving shaft 13 around the sun by rotation of the wafer supporter material 12.

[0022] Under the wafer supporter material 12, the heater supporter material 15 is formed and the heater 16 of the shape of a circular ring of the inside and two outsides is supported by this heater supporter material 15 along with the migration locus of Wafer W.

[0023] The 1st raw gas regurgitation nozzle (1st raw gas discharge part) 20 and the 2nd raw gas regurgitation nozzle (2nd raw gas discharge part) 21 are formed in ceiling wall 11a of a chamber 11 in the condition of having made the gas deliveries 20a and 20b countering the top face of the wafer supporter material 12. The raw gas regurgitation nozzle 20 of these 1st and every 2nd two raw gas regurgitation nozzle 21 are formed as shown in drawing 2, and these are arranged in the shape of a periphery along with the migration locus of Wafer W by turns. Moreover, the adjoining 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21 are arranged at the include angle of 90 degrees centering on the revolving shaft 13. Moreover, it is prepared in ceiling wall 11a of a chamber 11 so that it may be located between the 1st raw gas regurgitation nozzle 20 which four purge gas regurgitation nozzles (purge gas discharge part) 22 adjoin, and the 2nd raw gas regurgitation nozzle 21.

[0024] Drawing 3 (a) is the sectional view of the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21. As shown in drawing 3 (a), the 1st and 2nd raw gas regurgitation nozzles 20 and 21 have many gas deliveries 20a and 21a, respectively, and they are constituted so that the regurgitation of the raw gas may be carried out to the shape of a shower into a chamber 11 from the deliveries 20a and 21a of these large number. Moreover, drawing 3 (b) is the sectional view of the purge gas regurgitation nozzle 22. As shown in drawing 3 (b), the purge gas regurgitation nozzle 22 While having skirt-board section 22b in which delivery 22a of a large number prepared in the interior and delivery 22a of these large number were prepared caudad and carrying out the regurgitation of the raw gas to the shape of a shower into a chamber 11 from delivery 20a It has prevented that the flow of the purge gas breathed out by skirt-board section 22b in the shape of a shower is spread, and it is constituted so that the downflow of purge gas may make an air curtain by this.

[0025] Moreover, gas delivery 22a of the purge gas regurgitation nozzle 22 is prepared more nearly up than the gas deliveries 20a and 21a of the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21, and, thereby, is disengageable with the air curtain of purge gas about the 1st raw gas ambient atmosphere and the 2nd raw gas ambient atmosphere. Predetermined gas is supplied from these nozzles 20, 21, and 22 by the gas supply device 30 mentioned later.

[0026] The gas supply device 30 has CIF3 source of supply 31 which supplies CIF3 which is cleaning gas, the



Ar source of supply 32 which supplies Ar, TiCl<sub>4</sub> source of supply 33 which supplies TiCl<sub>4</sub>, and NH<sub>3</sub> source of supply 34 which supplies NH<sub>3</sub>. and -- ClF<sub>3</sub> source of supply 31 -- ClF<sub>3</sub> gas line 35 -- TiCl<sub>4</sub> gas line 37 is connected to TiCl<sub>4</sub> source of supply 33, and NH<sub>3</sub> gas line 38 is connected to NH<sub>3</sub> source of supply 34 for the Ar gas line 36 at the Ar source of supply 32, respectively. And the bulb 40 and the massflow controller 41 are formed in each Rhine.

[0027] TiCl<sub>4</sub> gas line 37 prolonged from TiCl<sub>4</sub> source of supply 33 is connected to the gas piping 42 prolonged from the 1st raw gas regurgitation nozzle 20. Moreover, the piping 45 prolonged from the Ar gas line 36 is connected to TiCl<sub>4</sub> gas line 37, and TiCl<sub>4</sub> gas by which the carrier was carried out to Ar gas is breathed out from the 1st raw gas regurgitation nozzle 20 through piping 42. Moreover, NH<sub>3</sub> gas line 38 prolonged from NH<sub>3</sub> source of supply 34 is connected to the gas piping 43 prolonged from the 2nd raw gas regurgitation nozzle 21, and NH<sub>3</sub> gas is breathed out from the 2nd raw gas regurgitation nozzle 21 through NH<sub>3</sub> gas line 38 and gas piping 43. Furthermore, the Ar gas line 36 prolonged from the Ar source of supply 32 is connected to the piping 44 prolonged from the purge gas regurgitation nozzle 22, and Ar gas is breathed out from the purge gas regurgitation nozzle 22 through the Ar gas line 36 and piping 44. Piping 46, 47, and 48 is connected to ClF<sub>3</sub> gas line 35 prolonged from ClF<sub>3</sub> source of supply 31 further again, and the regurgitation [ ClF<sub>3</sub> gas which is cleaning gas through these piping 46, 47, and 48 to the piping 42, 43, and 44 from the 1st raw gas regurgitation nozzle 20, the 2nd raw gas regurgitation nozzle 21, and the purge gas regurgitation nozzle 22 ] is possible. In addition, Bulbs 45a, 46a, 47a, and 48a are formed in piping 45, 46, 47, and 48, respectively.

[0028] The exhaust port 25 is established in that center section at bottom wall 11b of a chamber 11, and the exhaust pipe 26 is connected to this exhaust port 25. The exhauster 28 is connected to this exhaust pipe 26, and the inside of a chamber 11 can be decompressed to a predetermined degree of vacuum by operating an exhauster 28.

[0029] In addition, an exhaust pipe 26 is prolonged in a perpendicular direction lower part from an exhaust port 25, is the middle and is crooked horizontally, said revolving shaft 13 passed along the inside of the vertical section of an exhaust pipe 26, the tube wall of the horizontal level of an exhaust pipe 26 was penetrated, it has extended below, and the fluid seal 27 is formed between the tube wall and revolving shaft 13.

[0030] Thus, in the constituted CVD membrane formation equipment, first, the semi-conductor wafer W is inserted in in a chamber 11, and Wafer W is laid in wafer supporter 12a of the wafer supporter material 12. Subsequently, the wafer supporter material 12 is rotated heating Wafer W from a heater 16, the inside of a chamber 11 is exhausted with an exhauster 28, and the inside of a chamber 11 is made into a predetermined vacua. Then, Ar gas as purge gas is made to breathe out the 2nd raw gas regurgitation nozzle 21 to NH<sub>3</sub> gas for TiCl<sub>4</sub> gas which carried out the carrier to Ar from the 1st raw gas regurgitation nozzle 20 from the purge gas regurgitation nozzle 22, respectively.

[0031] About two sheets by which TiCl<sub>4</sub> gas breathed out from the 1st raw gas regurgitation nozzle 20 is supplied to the beginning among the wafers W of wafer supporter 12a of the wafer supporter material 12 After the monoatomic layer of Ti adsorbs by TiCl<sub>4</sub> supplied gas, by rotation of the wafer supporter material 12 The air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22 is passed, the monoatomic layer of N accumulates on the monoatomic layer of Ti by NH<sub>3</sub> gas breathed out from the 2nd raw gas regurgitation nozzle 21, these react, and TiN is formed. Furthermore, after passing the air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22, the monoatomic layer of Ti and the monoatomic layer of N are supplied similarly, this is repeated the number of predetermined times, and the TiN film of predetermined thickness is formed. moreover, about other two sheets to which NH<sub>3</sub> gas first breathed out from the 2nd raw gas regurgitation nozzle 21 is supplied After the monoatomic layer of N adsorbs by NH<sub>3</sub> supplied gas, by rotation of the wafer supporter material 12 The air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22 is passed, the monoatomic layer of Ti accumulates on the monoatomic layer of N by TiCl<sub>4</sub> gas breathed out from the 1st raw gas regurgitation nozzle 20, these react, and TiN is formed. Furthermore, after passing the air curtain of Ar gas breathed out from the purge gas regurgitation nozzle 22, the monoatomic layer of N and the monoatomic layer of Ti are supplied similarly, this is repeated the number of predetermined times, and the TiN film of predetermined thickness is formed. In this case, the rotational speed of the wafer supporter material 12 is determined according to the rate of adsorption of TiCl<sub>4</sub> gas which is raw gas, and NH<sub>3</sub> gas.

[0032] Moreover, further, a quantity of gas flow is set up so that the configuration of the 1st raw gas regurgitation nozzle 20 which can be set in this case, and the 2nd raw gas regurgitation nozzle 21 and spacing with Wafer W, and flow by which a monoatomic layer sticks to Wafer W equally can be formed. Moreover,

further, a quantity of gas flow is set up so that spacing of the purge gas regurgitation nozzle 22 and Wafer W and the flow as which purge gas functions considering a  $\text{TiCl}_4$  gas ambient atmosphere and  $\text{NH}_3$  gas ambient atmosphere as an air curtain disengageable enough can be formed. Moreover, the heating temperature of a heater 16 is set as the proper temperature suitable for the reaction of Ti and N. Hereafter, these set points are described concretely.

[0033] The 1st raw gas regurgitation nozzle 20 which has the structure shown in drawing 3 (a), and the 2nd raw gas regurgitation nozzle 21 can be arranged so that the distance  $h_1$  between Deliveries 20a and 21a and the wafer W front face held at the substrate supporter material 12 located caudad may be set to 0.1-10mm. Moreover, the purge gas regurgitation nozzle 22 which has the structure shown in drawing 3 (b) can be arranged so that the distance  $h_2$  between delivery 22a and the wafer W front face held at the substrate supporter material 12 located caudad may be set to 0.1-50mm, and it can be arranged so that the distance  $h_3$  between the lower limit and substrate supporter material 12 top faces may be set to 1.1-50mm. Preferably,  $h_1$  arranges nozzles 20, 21, and 22 so that 0.1-5mm and  $h_2$  may be set to 0.2-10mm and  $h_3$  may be set to 1.2-11mm.

[0034] Moreover, each quantity of gas flow at the time of TiN membrane formation, chamber internal pressure, and heating temperature can be set up as follows.

$\text{TiCl}_4$  quantity of gas flow: It is 5 - 20sccm (0.005 - 0.02 L/min) preferably one to 50 sccm (0.001 - 0.05 L/min).

Ar gas (carrier gas) flow rate: --  $\text{NH}_3$  quantity-of-gas-flow:50 which does not need to use carrier gas when 10 - 100sccm (0.01 - 0.1 L/min) and  $\text{TiCl}_4$  gas are low flow rates - 1000sccm (0.05 - 1 L/min) -- desirable -- 50 - 500sccm (0.05 - 0.5 L/min)

Purge-gas flow rate: 100 - 1000sccm (0.1 - 1 L/min)

chamber internal pressure: -- 100mTorr - 5Torr (13.3Pa - 665Pa) -- desirable -- 100mTorr(s) - 1Torr (13.3Pa - 133Pa)

Heating temperature: It is 400-600 degrees C [0035] preferably 300-700 degrees C. Supplying  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas, respectively from the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21 which have been arranged by turns as mentioned above Without using a high-speed switching valve, since the wafer supporter material 12 is rotated and  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas are supplied to Wafer W by turns, the monoatomic layer of Ti and the monoatomic layer of N can be formed by turns by the ALD method, and the desired TiN film can be formed. Moreover, since two or more wafers W are laid in the wafer supporter material 12 in this way and membrane formation processing of two or more sheets is performed by one processing, productivity is high. Moreover, since the raw gas of the part which formation of the monoatomic layer of Wafer W ended by being able to prevent that  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas are mixed by breathing out Ar gas as purge gas from the purge gas regurgitation nozzle 22, and forming an air curtain as much as possible, and carrying out the regurgitation of the Ar gas which is purge gas can be removed promptly and an excessive reaction can be prevented, the better film can be formed.

[0036] When it carries out by having repeated formation of such TiN film and membrane formation processing of the wafer W of predetermined number of sheets is completed, nozzles 20, 21, and 22 to  $\text{ClF}_3$  gas is made to breathe out through a gas line 35, piping 46, 47, and 48, and piping 42, 43, and 44 from  $\text{ClF}_3$  source 31, and the inside of a chamber 11 is cleaned.

[0037] The  $\text{ClF}_3$  quantity of gas flow at the time of this cleaning, chamber internal pressure, and cleaning temperature can be set up as shown below.

$\text{ClF}_3$  quantity of gas flow: It is 200 - 300sccm (0.2 - 0.3 L/min) preferably 100 to 500 sccm (0.1 - 0.5 L/min).

Chamber internal pressure: It is 1 - 5Torr (133-665Pa) preferably one to 10 Torr (133-1330Pa).

Cleaning temperature: It is 200-300 degrees C [0038] preferably 200-500 degrees C. Next, the CVD membrane formation equipment concerning other operation gestalten is explained. Drawing 4 is the sectional view showing partially the CVD membrane formation equipment concerning other operation gestalten. Here, it has the composition of using wafer supporter material 12' instead of the wafer supporter material 12, and making Wafer W rotating. That is, four wafer tables (two are illustrated in drawing 4) 52 are formed pivotable on the base member 51, and wafer supporter material 12' makes the wafer W on the wafer table 52 rotate by rotating these wafers table 52 by the motor 53. Thereby,  $\text{TiCl}_4$  gas as raw gas and  $\text{NH}_3$  gas can be further supplied to homogeneity at Wafer W, and a more uniform monoatomic layer can be formed. In this case, if a heater 16 is under wafer supporter material like drawing 1, since heating effectiveness will worsen, it is desirable to prepare heater 16' above Wafer W like drawing 4. 15' is heater supporter material which supports heater 16'. Thus,

when a heater is formed, it is desirable to prepare the hole of a large number in which gas passage is possible in heater 16' and heater supporter material 15' so that raw gas may be supplied effective in Wafer W.

[0039] Furthermore, he is trying to supply  $\text{TiCl}_4$  gas as raw gas, and  $\text{NH}_3$  gas from the shower head 60 and the shower head 61 with the operation gestalt of drawing 5, respectively. Much gas discharge opening 60b is formed in the inferior surface of tongue of body 60a of the hollow which makes the shape of a disk, and the shower head 60 carries out the regurgitation of the gas to homogeneity from this gas discharge opening 60b, as shown in drawing 6. The shower head 61 is constituted similarly. Thus,  $\text{TiCl}_4$  gas and  $\text{NH}_3$  gas can be supplied to Wafer W also by using the shower head instead of a nozzle at homogeneity.

[0040] With the operation gestalt of drawing 7, the exhaust port 70 is established directly under the 1st raw gas regurgitation nozzle 20 and the 2nd raw gas regurgitation nozzle 21 further again (only the exhaust port corresponding to the 1st raw gas regurgitation nozzle 20 is illustrated). By doing in this way,  $\text{TiCl}_4$  unnecessary gas and  $\text{NH}_3$  gas can be promptly discharged through the exhaust pipe 71 connected to the exhaust port 70.

[0041] In addition, this invention is variously deformable, without being limited to the gestalt of the above-mentioned implementation. For example, although the above-mentioned operation gestalt showed the example which forms the  $\text{TiN}$  film, aluminum  $2\text{O}_3$ ,  $\text{ZrO}_2$ ,  $\text{TaN}$ ,  $\text{SiO}_2$  and  $\text{SiN}$ ,  $\text{SiON}$ ,  $\text{WN}$  and  $\text{WSi}$ ,  $\text{RuO}_2$  grade, and other metallic compounds can be formed similarly. Moreover, with the above-mentioned operation gestalt, although  $\text{NH}_3$  gas was used as the 2nd raw gas, using  $\text{TiCl}_4$  as the 1st raw gas, the 1st raw gas and 2nd raw gas can use the proper gas according to the metallic-compounds film which forms membranes. in such a case, as the 1st raw gas which can be set Besides  $\text{TiCl}_4$ ,  $\text{TaBr}_5$ ,  $\text{Ta}(\text{OC}_2\text{H}_5)_5$ ,  $\text{SiCl}_4$ ,  $\text{SiH}_4$ ,  $\text{Si}_2\text{H}_6$ ,  $\text{SiH}_2\text{Cl}_2$ , aluminum of  $\text{WF}_6$  grade, The thing containing one sort in  $\text{Zr}$ ,  $\text{Ti}$ ,  $\text{Ta}$ ,  $\text{Si}$ ,  $\text{W}$ , and  $\text{Ru}$  can be mentioned, and the thing containing  $\text{N}$  or  $\text{O}$  of  $\text{NH}_3$  ( $\text{N}_2$ ),  $\text{O}_2$ ,  $\text{O}_3$ ,  $\text{NO}$ ,  $\text{N}_2\text{O}$ ,  $\text{N}_2\text{O}_3$ , and  $\text{N}_2\text{O}_5$  grade other than  $\text{NH}_3$  can be mentioned as the 2nd raw gas.

[0042] Moreover, although it prepared in the example of drawing 1 and the location of a heater was prepared above the wafer in the example of drawing 4 under the wafer, you may prepare in both these, and as long as it can heat to homogeneity, you may prepare in other locations. Furthermore, although  $\text{Ar}$  gas was used as purge gas, you may be other gas, such as  $\text{N}_2$  gas. Moreover, if two raw gas can be intercepted effectively, it is not necessary to use purge gas. You may be the substrate which may be not only a semi-conductor wafer but other things as a substrate to be used, and formed other layers on the front face further again.

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[Translation done.]

\* NOTICES \*

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] The sectional view showing the CVD membrane formation equipment concerning 1 operation gestalt of this invention.

[Drawing 2] The top view showing the interior of the CVD membrane formation equipment of drawing 1 .

[Drawing 3] The sectional view of the 1st raw gas regurgitation nozzle in the CVD membrane formation equipment of drawing 1 , and a purge gas regurgitation nozzle.

[Drawing 4] The sectional view showing partially the CVD membrane formation equipment concerning other operation gestalten of this invention.

[Drawing 5] The sectional view showing partially the CVD membrane formation equipment concerning the operation gestalt of further others of this invention.

[Drawing 6] The perspective view showing the shower head used for the equipment of drawing 4 .

[Drawing 7] The sectional view showing partially the CVD membrane formation equipment concerning the operation gestalt of further others of this invention.

[Description of Notations]

11; chamber

12 12'; wafer supporter material

12a; wafer supporter

13; revolving shaft

14; motor

16 16'; heater

20 21; raw gas regurgitation nozzle

22; purge gas regurgitation nozzle

30; gas supply device

25 70; exhaust port

26 71; exhaust pipe

28; exhauster

52; wafer table

53; motor

60 61; shower head

W; semi-conductor wafer

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[Translation done.]

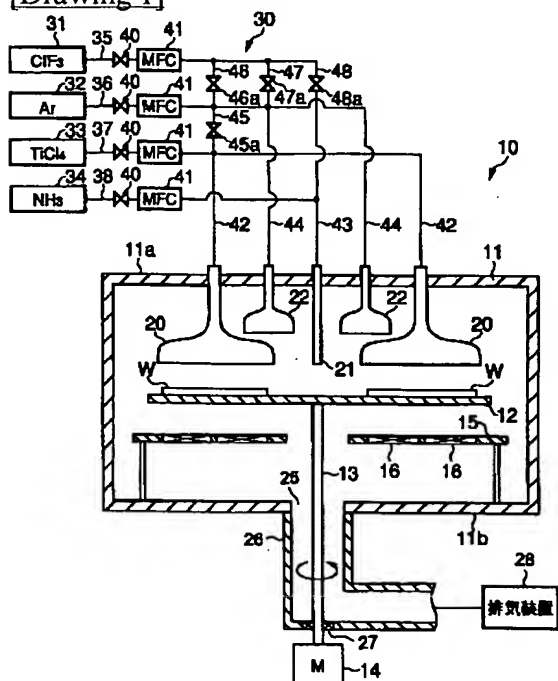
**\* NOTICES \***

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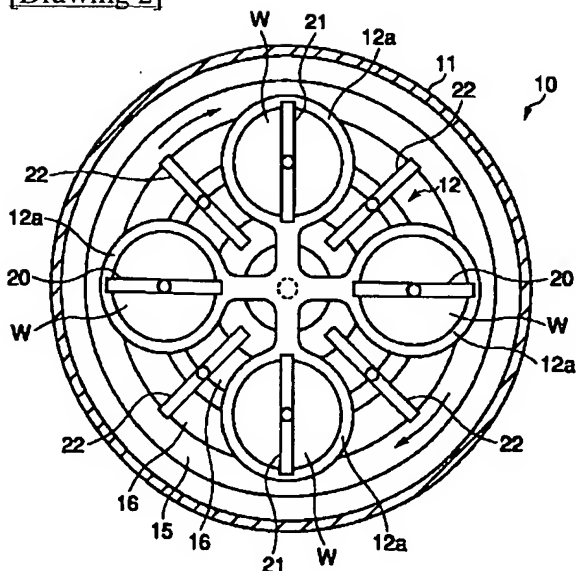
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## DRAWINGS

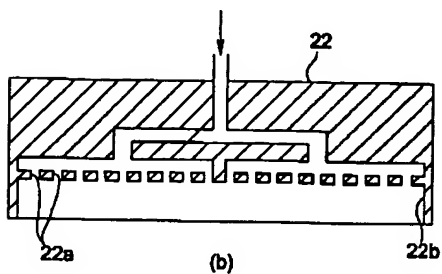
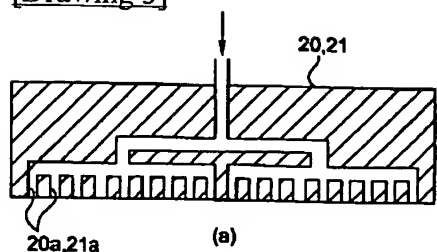
[Drawing 1]



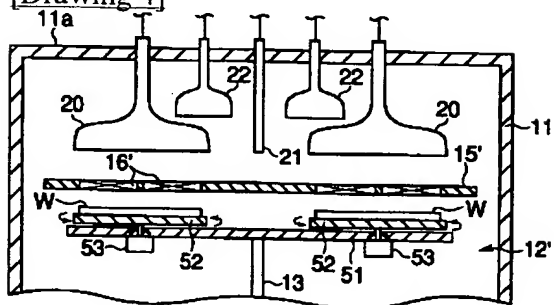
[Drawing 2]



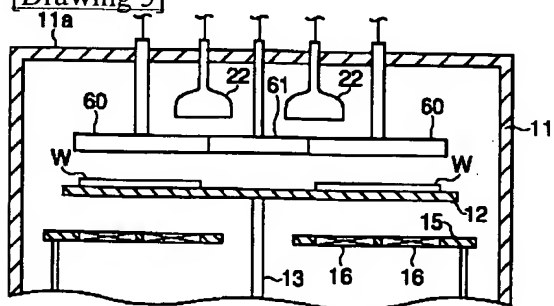
[Drawing 3]



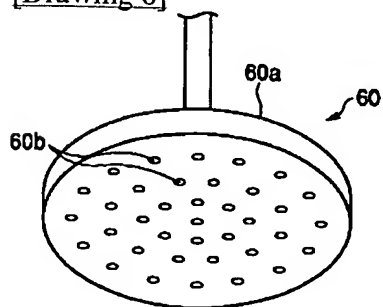
[Drawing 4]



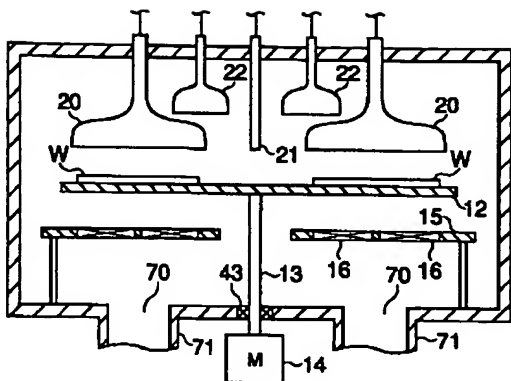
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]